

Phosphorus Fertilized Pasture and Composition of Cow Bone

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A DIRECT relationship between the quality of bone and forage has been long accepted by livestock producers, but with limited actual trials recorded. Fertility of soil and mineral content of pasture forage are generally regarded as requirements of good bone formation and development as well as for overall performance of grazing cattle. Mature cows have approximately 83.6 per cent of the total body phosphorus in their bones (Ellenberger, Newlander and Jones, 1950). These workers found no large differences in percentages of phosphorus and calcium between the various bones of the bovine skeleton. Becker et al. (1957) reported values for breaking strength of cannon bones of dairy cows and related some differences to dietary factors.

The present study was made to determine the effect of phosphorus applied as fertilizer to pasture on the breaking strength, density and concentration of several elements in bone of grazing cows.

EXPERIMENTAL

The fertilizer treatments were on a 42.5 hectare site of Immokalee fine sand at the Range Cattle Experiment Station, Ona, in central Florida, which had been cleared of native vegetation and planted to pangolagrass, *Digitaria decumens* Stent, during 1947-49. Seven different pasture treatments were established: No phosphate (Control), Superphosphate-no lime (Super-no lime), Superphosphate+lime (Super+lime); Concentrated superphosphate (Conc), Rock phosphate (Rock), Colloidal phosphate (Colloidal), and Basic slag. Each treatment involved 6.07 hectares consisting of two non-adjacent 3.04 hectare areas which were in turn divided equally in 1949 to permit an improved rotational grazing program.

In Table 1 the phosphorus fertilizer treatments are outlined. Calcic lime was applied to the Super+lime treatment in 1947, 1950 and 1953 at the rate of 1118 kg per hectare. All areas except the Super-no lime received 2236 kg of dolomitic lime per hectare in 1955 and 1118 kg calcic lime in 1959-60. All treatments had identi-

TABLE 1

Fertilizer applications to pastures, expressed in kg P_2O_5 per hectare

P Source	1947-54		1955-58	
	Kg P_2O_5	Interval	Kg P_2O_5	Interval
Control	none	—	none	—
Super - no lime	56.8	annual	28.4	annual
Super + lime	56.8	annual	28.4	annual
Conc	56.8	annual	28.4	annual
Basic slag	56.8	annual	28.4	annual
Rock	580	every 3rd yr.	none	none after 1953
Colloidal	545	every 3rd yr.	227	in 1957

cal nitrogen, potassium and minor element applications and were presented in detail by Hodges et al. (1964).

No phosphatic fertilizers were applied in any treatment after 1958. During the years 1959 through 1965 the cows were observed for residual effects of the phosphate fertilizer applications. The cows depended entirely on pasture up to 1958, but due to severe weather some low phosphorous feed supplementation in the form of cottonseed hulls and citrus molasses which contained 0.06-0.07 per cent phosphorus as well as urea was necessary during parts of the winter and spring of 1958, 1960 and 1963. Each herd group had free access to common salt and a mineral mixture consisting of 100 parts common salt, 10 parts iron oxide, 2 parts copper sulfate, and 0.1 part cobalt chloride in a two-compartment box. The only phosphorus and calcium provided to the grazing herds was in the forage.

The number of cows on each treatment depended on the amount of pangolagrass forage. Five animals were always on the Control pasture, but 7-10 were kept in the other pastures depending upon forage supply. They generally calved in a 110 day period during January to April and the calves were weaned in September.

Metatarsal or metacarpal bones were obtained from 28 cows when they were removed from the project after approximately 10-18 years of age. Breaking strength was obtained using a Riehle stress machine following the technique of Miller et al. (1962). This procedure involved the static stress weight for breaking bone, distance between supporting edges and cross-section area of bone at breaking point as determined with a planimeter for the calculation

of breaking strength. Density value was determined by weighing a 10-20 gm sample of cortical bone from the breaking point area in air and in water and dividing weight in air by that obtained in water. A bone sample from the breaking area was dried at 100C to dry weight in an oven, and ash determined by heating overnight at 600C (A.O.A.C. 1960). Phosphorus was determined in ash by the phosphomolybdate colorimetric method (Fiske and Subbarow, 1925); calcium, magnesium and iron using the Perkin Elmer Model 303 atomic absorption spectrophotometer technique, and fluorine by the distillation zirconium-alizarin method (Megregian and Maier, 1952; A.O.A.C., 1960).

RESULTS AND DISCUSSION

Values for breaking strength of bones of cows expressed as kg per cm² are presented in Fig. 1. The Control group was lowest in

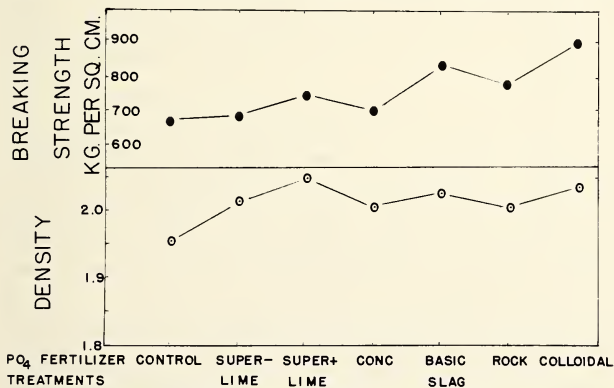


Fig. 1. Phosphorus fertilizer treatments of pasture versus breaking strength and density of cow bones.

breaking strength with an average value of 660 kg per cm². Cows grazing phosphate fertilized pastures had slightly greater average values in all six treatments. The Control group averaged a density value of 1.9567 compared to average values of more than 2.0000 for those grazing the phosphorus fertilized pastures. Cows of all treat-

ments had essentially the same quantity of forage per animal but varied in their total phosphorus intake. The Control group grazed grass that had 0.12 ± 0.02 per cent phosphorus on the dry weight basis during 1951-1958 compared to values of approximately 0.2-0.3 per cent phosphorus in those pastures fertilized with various sources of phosphorus. During the seven residual years, 1959-1965, forage from the readily soluble phosphate treatments decreased in phosphorus content to as low as 0.16 per cent.

The average concentration of ash, phosphorus and calcium values in bone of the seven treatment groups are shown in Fig. 2.

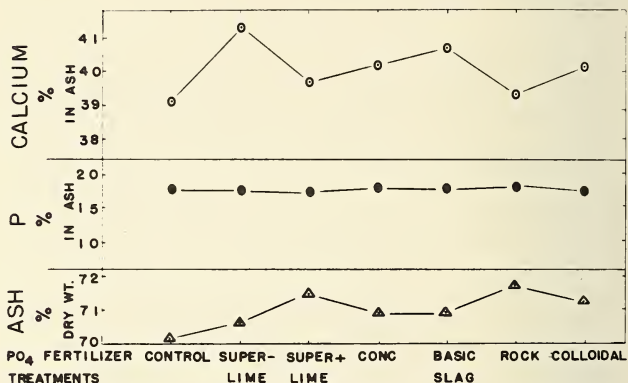


Fig. 2. Phosphorus fertilizer treatments of pasture versus ash, phosphorus, and calcium of cow bones.

The values for ash varied from 70.2-71.8 per cent with no significant difference among treatment groups. Strobino and Farr (1949) reported an average ash content for periosteal and endosteal bovine bone to be 69.7 and 71.4 per cent, respectively.

The average bone phosphorus values were quite constant among the treatment groups and varied only from a low of 17.5 ± 0.3 to a high value of 18.0 ± 1.1 per cent. These data indicate that productive beef cows consuming forage with approximately 0.12 per cent phosphorus can incorporate as much phosphorus in their bone as those grazing forage with 0.2-0.3 per cent phosphorus if the pasture

is not overgrazed. However, the Control cows had significantly less phosphorus in their blood (Shirley et al. 1968).

Calcium values (Fig. 2) in the bone did not vary significantly among the treatment groups. Calcium levels in the blood of these cows were not affected by the fertilizer and lime treatments (Shirley et al. 1968).

As shown in Fig. 3, the Super-no lime treatment group was not

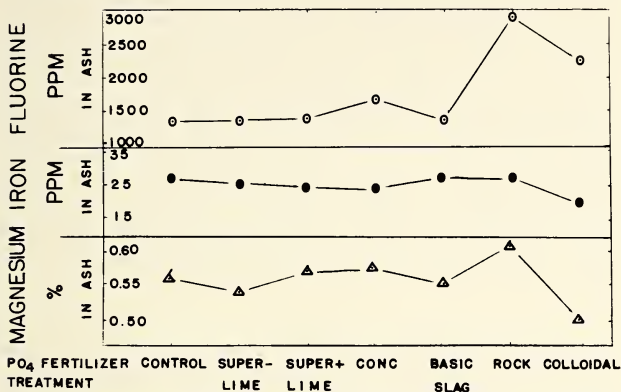


Fig. 3. Phosphatic fertilizer treatments of pastures versus magnesium, iron, and fluorine in cow bones.

significantly different in magnesium content of bone from the other groups although it was the only one that did not receive dolomitic limestone. Average values for all treatment groups were in the range of 0.5-0.6 per cent magnesium in the bone ash. Smith (1959) reported that bone ash in calves decreased from a normal value of approximately 0.75 per cent eventually to one-third of this value when serious clinical symptoms of magnesium deficiency occurred.

The average iron content in bone ash (Fig. 3) varied slightly from 18 to 28 ppm among the treatment groups. Anke (1966) demonstrated that young calves on rations containing 104 ppm iron had a significant decrease in bone iron content over a 140 day period compared to calves fed rations that contained 269 ppm of the element.

Average fluorine values are plotted in Fig. 3. Bones of cows

grazing the Rock and Colloidal fertilized pastures were significantly different. Duncan's (1955) test for significance showed that fluorine content of the Rock group was higher than all but the Colloidal group; and that the Colloidal group had more fluorine than the Control, Super-no lime, Super+lime and Basic slag groups. Fluorine occurs at levels of approximately 2-4 per cent in untreated colloidal and raw rock phosphate fertilizer. There was no raw rock phosphate applied after 1953 nor colloidal phosphate after 1957 and the cows were removed from the experiment generally 8-10 years afterwards. Hobbs and Merriman (1962) reported that the fluorine content of metacarpal, metatarsal and other bones of cattle was related to the level of fluorine ingested, source of fluorine and length of experimental period. Ammerman et al. (1964) found that steers in the feedlot during 91 days readily accumulated fluorine in the metacarpal bones from dietary colloidal phosphate, calcium fluoride and sodium fluoride. There was some indication of increased breaking strength and density in the present study with the higher levels of fluorine in the Rock and Colloidal treatment groups.

SUMMARY

A study was made of the effect of phosphorus applied as fertilizer in the form of Super- no lime, Super+lime, Conc, Basic slag, Rock and Colloidal phosphates to pangolagrass pastures on the breaking strength, density, ash, phosphorus, calcium, magnesium, and fluorine of metacarpal and metatarsal bones of cows that grazed the pastures for 7-16 years and were 12-18 years of age.

Cows grazing phosphatic fertilized pasture had slightly greater breaking strength and density of bone. Those that grazed pastures fertilized with rock and colloidal phosphates averaged approximately 2900 and 2300 ppm fluorine, respectively, compared to 1400 ppm fluorine in the other five treatment groups. There were no significant differences in composition of ash, phosphorus, calcium, magnesium, and iron in bone due to fertilizer treatments.

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